What is Claimed:

1. A method for separating ions of metallic elements in aqueous solution comprising:

providing an ion exchange comprising a carbon or graphite substrate impregnated with a hydrophobic chelating extractant having a greater affinity, at a selective pH, for ions of a first metallic element than for ions of a second metallic element, wherein said first element is different than said second element;

providing a solution comprising ions of said first and second metallic elements; and

contacting said ion exchange with said solution at said selective pH for a time sufficient for at least a portion of said ions of said first metallic element to become bound thereto.

2. A method according to Claim 1, wherein said carbon or graphite substrate is selected from the group consisting of molded carbon or graphite, vitreous (glassy) carbon, pyrolytic carbon or graphite, carbon composites, carbon or graphite powders, carbon or graphite particles, and carbon or graphite fibers.

3. A method according to Claim 2, wherein said carbon or graphite substrate comprises carbon or graphite fibers.

4. A method according to Claim 3, wherein said carbon or graphite fibers are in the form of carbon or graphite felt.

5. A method according to Claim 1, wherein said hydrophobic chelating extractant is selected from the group consisting of acidic organophosphorus extractants, neutral organophosphorus extractants, bifunctional organophosphorus extractants, basic extractants, hydroxyoximes, crown ethers, dithiosemicarbazones, and mixtures thereof.

6. A method according to Claim 5, wherein the hydrophobic chelating extractant is an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA.

7. A method according to Claim 1, wherein said first metallic element is ^{201}Pb and said second metallic element is ^{201}Tl, and the pH of said aqueous solution in greater than or equal to about 2.5.

8. A method according to Claim 7, wherein the hydrophobic chelating extractant is an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA.

9. A method according to Claim 8, wherein said acidic organophosphorus extractant is DEHPA.

10. A method according to Claim 7, wherein said solution is an aqueous acid solution that comprises an acid selected from the group consisting of hydrochloric acid, perchloric acid, sulfuric acid and nitric acid.

11. A method according to Claim 10, wherein said aqueous acid solution comprises nitric acid.

12. A method according to Claim 1, wherein said first metallic element is ^{99}Mo and said second metallic element is ^{99m}Tc, and the pH of said aqueous solution is from about 1 to about 2.

13. A method according to Claim 12, wherein the hydrophobic chelating extractant is an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA.

14. A method according to Claim 13, wherein said acidic organophosphorus extractant is DEHPA.

15. A method according to Claim 13, wherein said acidic organophosphorus extractant is EHEHPA.

16. A method according to Claim 12, wherein said aqueous solution is an aqueous acid solution that comprises an acid selected from the group consisting of hydrochloric acid, perchloric acid, sulfuric acid, or nitric acid.

17. A method according to Claim 16, wherein said aqueous acid solution comprises nitric acid.

18. The method according to Claim 1 further comprising contacting said ion exchange with a second aqueous solution at a selective pH and after a time sufficient for said second element to be produced from radioactive decay of said first element.

19. The method according to Claim 18 wherein said first metallic element is ^{201}Pb and said second metallic element is ^{201}Tl, and the pH of said second aqueous solution in greater than or equal to about 2.5.

20. A method according to Claim 19, wherein said second aqueous solution is selected from the group consisting of dilute nitric acid, dilute hydrochloric acid, ammonium acetate buffer, brine, and water.

21. A method according to Claim 20, wherein said brine is 0.9% NaCl.

22. The method according to Claim 18 wherein said first metallic element is ^{99}Mo and said second metallic element is ^{99m}Tc.

23. The method according to Claim 22 wherein the pH of said second aqueous solution is from about 1 to about 2.

24. The method according to claim 23 wherein said second aqueous solution is selected from the group consisting of hydrochloric acid and nitric acid.

25. A method according to Claim 1, wherein said first metallic element and said second metallic element belong to different Groups in the long periodic table.

26. A method according to Claim 1, wherein said first metallic element and said second metallic element belong to the same Group in the long periodic table.

27. A method for separating ions of metallic elements comprising:

providing an ion exchange comprising a carbon or graphite substrate impregnated with a hydrophobic chelating extractant having a greater affinity, at a first selective pH, for ions of a first metallic element than for ions of a second metallic element, wherein said first element is different than said second element; and wherein said first metallic element is bound to said extractant; and

contacting said ion exchange with an aqueous solution at a second selective pH and after a time sufficient for said second element to be produced from radioactive decay of said first element.

28. A method according to Claim 27 wherein said carbon or graphite substrate is selected from the group consisting of molded carbon or graphite, vitreous (glassy) carbon, pyrolytic carbon or graphite, carbon composites, carbon or graphite powders, carbon or graphite particles, and carbon or graphite fibers.

29. A method according to Claim 28, wherein said carbon or graphite substrate comprises carbon or graphite fibers.

30. A method according to Claim 29, wherein said hydrophobic chelating extractant is selected from the group consisting of acidic organophosphorus extractants, neutral organophosphorus extractants, bifunctional organophosphorus extractants, basic extractants, hydroxyoximes, crown ethers, dithiosemicarbazones, and mixtures thereof.

31. A method according to Claim 30, wherein the hydrophobic chelating extractant is an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA.

32. A method according to Claim 27, wherein said first metallic element is ^{201}Pb and said second metallic element is ^{201}Tl, and said first and second selective pH is greater than or equal to about 2.5.

33. A method according to Claim 32, wherein said aqueous solution is selected from the group consisting of dilute nitric acid, dilute hydrochloric acid, ammonium acetate buffer, brine, and water.

34. A method according to Claim 33, wherein said brine is 0.9% NaCl.

35. A method according to Claim 27, wherein said first metallic element is ^{99}Mo and said second metallic element is ^{99m}Tc and said first selective pH is from about 1 to about 2.

36. A method according to Claim 35, wherein said second selective pH is from about 1 to about 2.

37. A separation column system for separating metallic elements comprising:

(a) a body portion having an inlet and an outlet;

(b) an ion exchange housed within said body portion, said ion exchange comprising a carbon or graphite substrate impregnated with a hydrophobic chelating extractant having a greater affinity, at a selective pH, for ions of a first metallic element than for ions of a second metallic element, wherein said first element is different than said second element;

(c) a solution at said selective pH, said solution comprising ions of said first and second metallic elements.

38. A separation column system according to Claim 37, wherein said first and second metallic elements belong to the same Group in the long periodic table.

39. A separation column system according to Claim 37, wherein said first and second metallic elements belong to different Groups in the long periodic table.

40. A separation column system according to Claim 37, wherein said carbon or graphite substrate is selected from the group consisting of molded carbon or graphite, vitreous (glassy) carbon, pyrolytic carbon or graphite, carbon composites, carbon or graphite powders, carbon or graphite particles, and carbon or graphite fibers.

41. A separation column system according to Claim 38, wherein said carbon or graphite substrate comprises carbon or graphite fibers.

42. A separation column system according to Claim 41, wherein said carbon or graphite fibers are in the form of carbon or graphite felt.

43. A separation column system according to Claim 37, wherein said hydrophobic chelating extractant is selected from the group consisting of acidic organophosphorus extractants, neutral organophosphorus extractants, bifunctional organophosphorus extractants, basic extractants, hydroxyoximes, crown ethers, dithiosemicarbazones, and mixtures thereof.

44. A separation column system according to Claim 43, wherein the hydrophobic chelating extractant is an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA.

45. A separation column system according to Claim 44, wherein said first metallic ion is ^{201}Pb and said second metallic ion is ^{201}Tl, and the pH of said solution is greater than or equal to about 2.5.

46. A separation column system according to Claim 44, wherein said first metallic ion is ^{99}Mo and said second metallic ion is ^{99m}Tc, and the pH of said solution is from about 1 to about 2.

47. A ^{201}Tl generator comprising:

(a) a body portion having an inlet and an outlet; and

(b) an ion exchange housed within said body portion, said ion exchange comprising carbon or graphite fibers impregnated with an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA, and said ion exchange further comprising ions of ^{201}Pb bound to said extractant.

48. A ^{201}Tl generator according to Claim 47, further comprising:

(c) an aqueous solution having a pH of greater than or equal to about 2.5 within said body portion and in contact with said ion exchange, said aqueous acid solution containing ^{201}Tl that has been produced by radioactive decay of said ^{201}Pb.

49. A ^{201}Tl generator according to Claim 48, wherein the pH of said aqueous solution is about 5.5.

50. A ^{201}Tl generator according to Claim 48, wherein said acidic organophosphorus extractant comprises DEHPA.

51. A ^{201}Tl generator according to Claim 48, wherein said aqueous solution is selected from the group consisting of dilute nitric acid, dilute hydrochloric acid, ammonium acetate buffer, brine, and water.

52. A ^{201}Tl generator according to Claim 51, wherein said brine is 0.9% NaCl.

53. A ^{99m}Tc generator comprising:

(a) a body portion having an inlet and an outlet; and

(b) an ion exchange housed within said body portion, said ion exchange comprising carbon or graphite fibers impregnated with an acidic organophosphorus extractant selected from the group consisting of DEHPA, EHEHPA, and DTMPPA, and said ion exchange further comprising ions of ^{99}Mo bound to said extractant.

54. A ^{99m}Tc generator according to Claim 53, further comprising:

(c) an aqueous solution having a pH of from about 1 to about 2 within said body portion and in contact with said ion exchange, said aqueous acid solution containing ^{99m}Tc that has been produced by radioactive decay of said ^{99}Mo.

55. A ^{99m}Tc generator according to Claim 54, wherein the pH of said aqueous solution is about 1.

56. A ^{99m}Tc generator according to Claim 54, wherein the pH of said aqueous solution is about 2.

57. A ^{99m}Tc generator according to Claim 54, wherein said aqueous solution is selected from the group consisting of hydrochloric acid and nitric acid.

58. A ^{99m}Tc generator according to Claim 53, wherein said acidic organophosphorus extractant comprises DEHPA.

59. A ^{99m}Tc generator according to Claim 53, wherein said acidic organophosphorus extractant comprises EHEHPA.